

Digital Twin of a Flexible Manufacturing System for Solutions Preparation

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Abstract: In the last few decades, there has been a growing necessity for systems that handle market changes and personalized customer needs with near mass production efficiency, defined as the new mass customization paradigm. The Industry 5.0 vision further enhances the human-centricity aspect, in the necessity for manufacturing systems to cooperate with workers, taking advantage of their problem-solving capabilities, creativity, and expertise of the manufacturing process. A solution is to develop a flexible manufacturing system capable of handling different customer requests and real-time decisions from operators. This paper tackles these aspects by proposing a digital twin of a robotic system for solution preparation capable of making real-time scheduling decisions and forecasts using a simulation model while allowing human interventions. A discrete event simulation model was used to forecast possible system improvements. The simulation handles real-time scheduling considering the possibility of adding identical parallel machines. Results show that processing multiple jobs simultaneously with more than one machine on critical processes, increasing the robot speed, and using heuristics that emphasize the shortest transportation time can reduce the overall completion time by 82%. The simulation model has an animated visualization window for a deeper understanding of the system.

Keywords: flexible manufacturing system; discrete event simulation; mass customization; Industry 5.0; digital twin; solution preparation